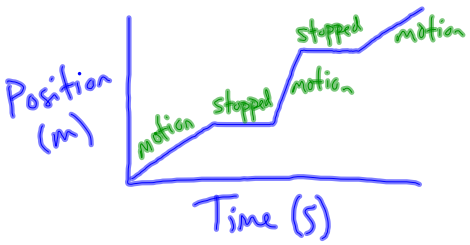
Position v. Time Graphs

- Position
  - Distance → always positive
  - Displacement → can be positive or negative, depending on your starting point
  - Either have distance or displacement on y-axis
- Time
  - x-axis
  - Always increases
- Example:



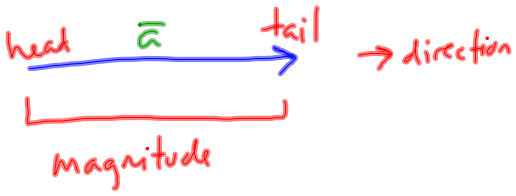
- Slope = $\frac{\text{position}}{\text{time}}$ = speed / velocity
  - Steeper the slope, the faster the object moves
  - Slope of Ø means object is not moving

Scalars v. Vectors

- Scalar → measurement that only has "how much" (magnitude)
- Vector → measurement that has both "how much" (magnitude) and "what direction" (direction)
- Scalar examples:
  - Amount of substance
  - Time
  - Distance
  - Mass
  - Volume
  - Speed
- Vector examples:
  - Velocity
  - Displacement
  - Acceleration

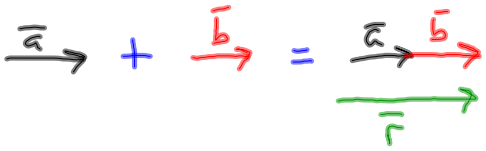
Vector Addition

- We draw vectors as arrows.
  - Length of arrow = magnitude
  - Direction of arrow = direction



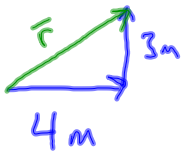
$\bar{a}$ → the bar means it is a vector

- Adding vectors
  - Place them head to tail



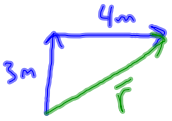
$\bar{r}$ = Resultant vector

- Process of adding vectors:



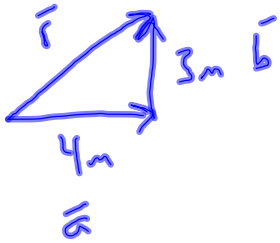
$\bar{r}$ = Resultant vector is drawn from head of 1st vector to tail of last vector

- Order of addition does not matter



- To find the magnitude of the resultant vector, we use the Pythagorean theorem.

$$a^2 + b^2 = c^2$$



$$a^2 + b^2 = r^2$$

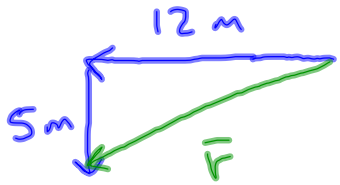
$$r = \sqrt{a^2 + b^2}$$

$$= \sqrt{(4\,m)^2 + (3\,m)^2}$$

$$= 5\,m$$

$\bar{r} = 5\,m$ northeast

- Example:



$$r = \sqrt{(5\,m)^2 + (12\,m)^2}$$

$$= 13\,m$$

$\bar{r} = 13\,m$ southwest

Equations

- $\text{speed} = \frac{\text{distance}}{\text{time}}$ $\quad s = \frac{d}{t}$
- $\overline{\text{velocity}} = \frac{\overline{\text{displacement}}}{\text{time}}$ $\quad \bar{v} = \frac{\bar{d}}{t}$

- Calculate these for intervals on position v. time graphs
  - Overall interval
  - Sub-intervals